2015 ANNUAL BIOSOLIDS REPORT

JEFFERSON COUNTY COMMISSION ENVIRONMENTAL SERVICES DEPARTMENT

JEFFERSON COUNTY, ALABAMA

BIOSOLIDS MANAGEMENT PROGRAM

REPORT PREPARED BY:

Hazen

2015 Annual Biosolids Report

2015 EPA ANNUAL BIOSOLIDS REPORT

JEFFERSON COUNTY ENVIRONMENTAL SERVICES DEPARTMENT
BIRMINGHAM, ALABAMA

Enclosed is the 2015 Annual Biosolids Monitoring Report for the Jefferson County Environmental Services' **Biosolids Land Reclamation Program**. This report is respectfully submitted to the Environmental Protection Agency (EPA) in accordance with the requirements of 40 CFR Part 503.

Information provided in this report includes:

1. Certification Statement for management practices, site restrictions, pathogen requirement, and vector attraction reduction requirements.

2. Executive Summary.

3. Project information for the Biosolids Management Program, including Jefferson County Wastewater Treatment Facility information and land application site data.

4. Biosolids testing methodology and analysis results.

5. Agronomic calculations, supporting documentation and sample worksheet for calculating agronomic rates.

6. Vector Attraction Reduction Statistics.

7. Land application site maps.

SECTION 1

CERTIFICATION STATEMENT

CERTIFICATION STATEMENT FOR THE *PREPARER* and *APPLIER* OF BULK SEWAGE BIOSOLIDS

I certify, under penalty of law, that the information that will be used to determine compliance with the management practices in §503.14, the site restrictions in §503.32 (b)(5), the Class B pathogen requirements in §503.32(b), and the vector attraction reduction requirements in §503.33(b)(6) or (10)(i) was prepared for each site on which bulk sewage sludge is applied under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate this information. I am aware that there are significant penalties for false certification including the possibility of fine and imprisonment.

Signature

2/15/16

Date

David Denard – Director, Jefferson County Environmental Services Department

Printed Name and Position

SECTION 2

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The Jefferson County Environmental Services Department utilizes land application as the method of disposal for the biosolids currently produced by its wastewater treatment facilities. There are currently nine (9) wastewater treatment facilities operated by the Environmental Services Department. During 2015, these facilities treated an average daily flow of 107 MGD of wastewater and produced 8,166 dry tons of biosolids that were sent for land application. An additional approximately 2,250 dry tons were generated but used as ADEM-approved soil amendment for the cover soil at Jefferson County Landfill No. 1. Seven (7) of the County's wastewater treatment facilities are Class I Publicly-Owned Treatment Works (POTWs), and therefore subject to the 40 CFR Part 503 reporting regulations.

Throughout 2015, the biosolids produced by Jefferson County's wastewater treatment facilities were land applied at two (2) reclaimed strip mine sites and used as a soil amendment at the Jefferson County Landfill No. 1 (Mt. Olive Landfill), which is leased and operated by Santek Environmental of Alabama, LLC. Santek was the applier of the biosolids at the landfill. Jefferson County employees applied the biosolids at the reclamation sites.

The Beltona Land Reclamation Site, located in northern Jefferson County, is approximately 1,000 acres in size, with about one-third of the site being previously disturbed through mining activities. Biosolids from two (2) wastewater treatment facilities were applied at Beltona during 2015.

The Flat Top/Bessie Mines Land Reclamation Site (Flat Top) is located in northwestern Jefferson County and is approximately 4,670 acres total in size, with approximately 2,700 acres being disturbed through previous mining activities. Biosolids from eight (8) wastewater treatment facilities were applied at this site during 2015.

Applicable site restrictions, general requirements, and management practices have been met at both Land Reclamation Sites. Biosolids were applied to all sites using the "Pollutant Concentration" (PC) option. Pathogen and vector attraction reduction requirements and all required site restrictions for Class "B" biosolids were also met at each reclamation site.

SECTION 3
PROJECT INFORMATION

JEFFERSON COUNTY

WASTEWATER TREATMENT FACILITIES

System: Jefferson County Commission/Environmental Services Department
716 Richard Arrington, Jr. Boulevard North
Birmingham, AL 35203

Summary:

The Jefferson County Environmental Services Department currently operates nine wastewater treatment facilities. During 2015, these facilities treated an average daily flow of 107 MGD of wastewater and produced 10,416 dry (English) tons of biosolids that were land applied. Seven of the County's wastewater treatment facilities are Class I POTWs, and therefore subject to the 40 CFR Part 503 reporting regulations.

Class I POTWs:	**Dry Tons of Biosolids Land Applied**
1. Cahaba River Wastewater Treatment Plant NPDES Permit No. AL0023027	649.2
2. Five Mile Creek Wastewater Treatment Plant NPDES Permit No. AL0026913	1,497.5
3. Leeds Wastewater Treatment Plant NPDES Permit No. AL0022297	303.3
4. Trussville Wastewater Treatment Plant NPDES Permit No. AL0022934	721.7
5. Turkey Creek Wastewater Treatment Plant NPDES Permit No. AL0022936	343.2
6. Valley Creek Wastewater Treatment Plant NPDES Permit No. AL0023655	3,353.3
7. Village Creek Wastewater Treatment Plant NPDES Permit No. AL0023647	3,511.3
Non-Class I POTWs (<1.0 MGD):	
1. Prudes Creek Wastewater Treatment Plant NPDES Permit No. AL0056120	36.4
2. Warrior Wastewater Treatment Plant NPDES Permit No. AL0050881	0.0
	TOTAL: 10,416 Dry Tons

Reporting Requirements:

Based on the quantity of biosolids land applied during 2015, the required frequency of monitoring was six times per year. However, Jefferson County typically performs biosolids monitoring on a monthly basis (twelve times per year).

Pathogen Requirements:

Class “B” pathogen requirements were met through Alternative 1: The Monitoring of Fecal Coliform [503.32(b)(2)]. The geometric mean fecal coliform density per gram of dry biosolids was less than 2 million colony-forming units for each sampling event (see Biosolids Analysis Results).

Vector Attraction Reduction Summary:

A portion of the biosolids from the Valley Creek WWTP (approx. 20% of total) and a portion of the lime stabilized biosolids from Village Creek WWTP (3% of total) were land applied at the Beltona Land Reclamation Site in 2015. The Valley Creek WWTP utilized Option 1: Volatile Solids Reduction by a minimum of 38 percent [503.33(b)(1)]. The Village Creek wastewater treatment facility utilized Option 6: Addition of Alkaline Material [503.33(b)(6)] for vector attraction reduction of their biosolids.

The remaining biosolids from the Valley Creek WWTP and Village Creek WWTP and the six other WWTPs were land applied at the Flat Top/Bessie Mines application site or used as soil amendment at the landfill. For the reclamation sites, Jefferson County incorporated the biosolids into the soil within six hours of application as described in Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]. This method of vector attraction reduction was utilized for approximately 93% of the County’s total biosolids land applied during 2015. The biosolids from the Village Creek WWTP included lime stabilized biosolids associated with the centrifuge dewatering process and biosolids from drying beds.

Santek Environmental, the applier of the biosolids being used as soil amendment at the Jefferson County Landfill No. 1, was also instructed to incorporate the biosolids into the soil within six hours of application as described in Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)].

BELTONA LAND RECLAMATION SITE

System: Jefferson County Commission/Environmental Services Department
716 Richard Arrington, Jr. Boulevard North
Birmingham, AL 35203

Reporting Period:
January 1, 2015 to December 31, 2015

Site Address:
401-B Beltona Road, Warrior, AL 35180

Site Description:
The Beltona Land Reclamation Site, which is approximately 1,000 acres in size, is a former strip mine site located in northern Jefferson County. About one-third of the site has been utilized for biosolids land application, with plot sizes ranging from 3.0 acres to 20 acres. Jefferson County is assisting the property owner in the reclamation of this site through the land application of biosolids. Biosolids were land applied on roughly 143 acres at the site in 2015. Presently, Tifton Bermuda grass is grown at Beltona and are harvested several times a year as hay.

Source of Biosolids:
Biosolids from the Valley Creek and Village Creek wastewater treatment facilities were land applied at this site during January, February and March 2015 only.

Quantity:
760.2 dry (English) tons of biosolids were land applied at the Beltona Land Reclamation Site during January – March 2015.

Pollutant Limits:
Biosolids from two of the County's wastewater treatment facilities were applied to this site using the "Pollutant Concentration" (PC) option. Biosolids testing was performed on samples from these facilities at a frequency that meets or exceeds the minimum monitoring frequency requirement for each facility. Calculations were then performed to determine a weighted concentration of each pollutant applied to the site (see 2015 Biosolids Analysis Results).

Pathogen Requirements:
Class "B" pathogen requirements were met through Alternative 1: The Monitoring of Fecal Coliform [503.32(b)(2)]. The geometric mean fecal coliform density per gram of dry biosolids was less than 2 million colony-forming units for each sampling event (see 2015 Biosolids Analysis Results).

Vector Attraction Reduction Requirements:

The Village Creek wastewater treatment facility utilized lime stabilization for vector attraction reduction of their biosolids, as described in Option 6: Addition of Alkaline Material [503.33(b)(6)]. To satisfy the requirements of Option 6, sufficient lime was added to the biosolids to raise the pH to at least 12 for 2 hours and at least 11.5 for an additional 22 hours, without the addition of more lime. Lime stabilized biosolids were then surface-applied at the Beltona Land Reclamation Site.

The biosolids from the Valley Creek WWTP met requirements for Option 1: Volatile Solids Reduction by a minimum of 38 percent [503.33(b)(1)].

Management Practices and Site Restrictions:

All applicable management practices stated in 503.14 were met at the site, including a minimum 100 ft. buffer zone around waters of the United States.

All applicable site restrictions stated in 503.32(b)(5) for Class "B" biosolids were also met. The Beltona Land Reclamation Site is in a remote area of Jefferson County and is located on private property; therefore there is no public access to the site.

FLAT TOP/BESSIE MINES
LAND RECLAMATION SITE

System: Jefferson County Commission/Environmental Services Department
716 Richard Arrington, Jr. Boulevard North
Birmingham, AL 35203

Reporting Period:
January 1, 2015 to December 31, 2015

Site Address:
5201 Flat Top Road, Graysville, AL 35073

Site Description:
The Flat Top Land Reclamation Site is a former strip mine site, 4,670 acres total in size, with approximately 2,700 acres being previously disturbed through mining activities. Jefferson County is assisting the property owner in the reclamation of this site through the land application of biosolids. Biosolids were land applied on roughly 241 acres at the site in 2015.

There is currently marginal soil mass present at this site for growing vegetation and biosolids are being applied to build adequate soil mass.

Source of Biosolids:
During 2015, biosolids from eight wastewater treatment facilities were land applied at this site with no biosolids being hauled from the Warrior wastewater treatment facility.

Quantity:
A total of 7,406 dry (English) tons of biosolids were applied at the Flat Top Land Reclamation Site during 2015. Biosolids were applied to Plot 3 of the site (see Figure 2).

Pollutant Limits:
Biosolids were applied to this site using the "Pollutant Concentration" (PC) option (see 2015 Biosolids Analysis Results). Biosolids testing was performed on samples from these facilities at a frequency that meets or exceeds the minimum monitoring frequency requirement for each facility. Calculations were then performed to determine a weighted concentration of each pollutant applied to the site (see 2015 Biosolids Analysis Results).

Pathogen Requirements:
Class "B" pathogen requirements were met through Alternative 1: The Monitoring of Fecal Coliform [503.32(b)(2)]. The geometric mean fecal coliform density per gram of dry biosolids was less than 2 million colony-forming units for each sampling event (see 2015 Biosolids Analysis Results).

Vector Attraction Reduction Requirements:

The Village Creek wastewater treatment facility primarily utilized lime stabilization for vector attraction reduction in the majority of their biosolids in accordance with Option 6: Addition of Alkaline Material [503.33(b)(6)]. To satisfy the requirements of Option 6, sufficient lime was added to the biosolids to raise the pH to at least 12 for 2 hours and at least 11.5 for an additional 22 hours, without the addition of more lime

For biosolids received at the Flat Top Land Reclamation Site from the remaining treatment plants and the portion of biosolids from Village wastewater treatment facility that did not receive lime stabilization, the method of vector attraction reduction used was Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]. These biosolids were land applied and incorporated into the soil within six hours of application on the land. The biosolids from the Valley Creek WWTP also met requirements for Option 1: Volatile Solids Reduction by a minimum of 38 percent [503.33(b)(1)].

Management Practices and Site Restrictions:

All applicable management practices stated in 503.14 were met at the site, including a minimum 100 ft. buffer zone around waters of the United States.

All applicable site restrictions stated in 503.32(b)(5) for Class “B” biosolids were also met. The Flat Top/Bessie Mines Land Reclamation site is in a remote area of Jefferson County and is located on private property; therefore there is no public access to the site.

JEFFERSON COUNTY LANDFILL NO. 1

System: Jefferson County Commission/Environmental Services Department
716 Richard Arrington, Jr. Boulevard North
Birmingham, AL 35203

Reporting Period:

January 1, 2015 to December 31, 2015

Site Address:

101 Barber Boulevard, Gardendale, AL 35071

Site Description:

The Jefferson County Landfill No. 1, more commonly referred to as the Mt. Olive Landfill, is a municipal solid waste (MSW) landfill located in northern Jefferson County. Although owned by the Jefferson County Commission, the site, operations and management of the landfill is leased to Santek Environmental of Alabama, LLC.

Source of Biosolids:

In 2015, biosolids from the Five Mile, Leeds, Trussville, Turkey Creek and Village Creek wastewater treatment facilities were delivered to the landfill to be used as soil amendment in the cover soil of the landfill. The use of biosolids as soil amendment at this location has been approved by the Alabama Department of Environmental Management (ADEM). Although Jefferson County prepares and delivers the biosolids to the landfill, Santek is the applier of the biosolids at this site.

Quantity:

Approximately 2,250 dry (English) tons of biosolids were delivered to the Mt. Olive Landfill in 2015 to be used by Santek Environmental as soil amendment in their landfill cover soil.

Pollutant Limits:

Biosolids were delivered to this site in quantities that would meet the “Pollutant Concentration” (PC) option. Biosolids testing was performed on samples from these facilities at a frequency that meets or exceeds the minimum monitoring frequency requirement for each facility. Calculations were then performed to determine a weighted concentration of each pollutant applied to the site (see 2015 Biosolids Analysis Results).

Pathogen Requirements:

Class “B” pathogen requirements were met through Alternative 1: The Monitoring of Fecal Coliform [503.32(b)(2)]. The geometric mean fecal coliform density per gram of dry biosolids was less than 2 million colony-forming units for each sampling event (see 2015 Biosolids Analysis Results).

Vector Attraction Reduction Requirements:

As the applier of the biosolids at the Mt. Olive Landfill, Santek Environmental has been instructed to comply with Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)] within six hours of application on the land.

Management Practices and Site Restrictions:

Since the Mt. Olive Landfill is a municipal solid waste (MSW) landfill, subject to extensive siting and operational regulations, all applicable biosolids management practices stated in 503.14 are met at the site, including a minimum 100 ft. buffer zone around waters of the United States.

All applicable site restrictions stated in 503.32(b)(5) for Class "B" biosolids are also met through MSW regulations. The Mt. Olive landfill is in a remote area of Jefferson County with restricted public access to the site.

SECTION 4

BIOSOLIDS ANALYSIS

TEST METHODS FOR BIOSOLIDS ANALYSIS

Biosolids testing was performed on samples from each wastewater treatment facility at a frequency that meets or exceeds the minimum monitoring frequency requirement for each facility. Site-specific calculations were then performed to determine a weighted concentration of each pollutant applied to each site (see 2015 Biosolids Analysis Results).

METALS ANALYSIS:
Following is a list of the biosolids sample preparation and test methods used when performing metals testing:

METHODS FOR EVALUATING SOLID WASTE, SW846 METHODS:

Arsenic	3050B, 7060A
Cadmium	3050B, 7130
Chromium	3050B, 7190
Copper	3050B, 7210
Lead	3050B, 7420
Mercury	7471B
Molybdenum	3050B, 7481
Nickel	3050B, 7520
Selenium	3050B, 7740
Zinc	3050B, 7950

FECAL COLIFORM TESTING:
For each sampling event, seven (7) samples were collected and tested according to the procedure outlined in Part 9222D, *Standard Methods for the Examination of Water and Wastewater,* and Appendix F of EPA's *Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge*. The geometric mean fecal coliform density per gram of dry biosolids was less than 2 million colony-forming units for each sampling event (see 2015 Biosolids Analysis Results). Serial dilutions were prepared in the range of 10^1 through 10^6, and on some occasions 10^7, thus enabling coliform colony counts of greater than 20 million.

2015 BIOSOLIDS ANALYSIS RESULTS
BELTONA LAND RECLAMATION SITE
(Based on Mass-Balance Calculations)

	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn	TKN	Fecal Coliform
Date	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**CFU/g***
January	<PQL	<PQL	41	505	47	<PQL	15	40	<PQL	1,286	42,945	135,523
February	<PQL	<PQL	40	448	40	1.1	15	39	<PQL	1,191	39,198	76,814
March	<PQL	<PQL	37	406	44	0.6	7.6	30	<PQL	1,159	60,274	7,613
April	NO ADDITIONAL BIOSOLIDS APPLIED AT BELTONA IN 2015											
May												
June												
July												
August												
September												
October												
November												
December												
Average	**<PQL**	**<PQL**	**39**	**453**	**43**	**0.6**	**13**	**28**	**<PQL**	**1,212**	**47,472**	**73,317**
Maximum	**<PQL**	**<PQL**	**41**	**505**	**47**	**1.1**	**15**	**41**	**<PQL**	**1,286**	**60,274**	**135,523**
PQL	11	5.0	6.0	5.0	12	0.6	6.0	6.0	12	8.0	11	
EQ/PC Limit[1]	41	39	-	1,500	300	17	-	420	100	2,800	-	-
Ceiling Limit[2]	75	85	-	4,300	840	57	75	420	100	7,500	-	-

PQL = Practical Quantitation Limit

* Geometric mean fecal coliform density

[1] Pollutant Concentration Limits taken from Table 3, Part 503.13

[2] Ceiling Concentration Limits taken from Table 1, Part 503

2015 BIOSOLIDS ANALYSIS RESULTS
FLAT TOP/BESSIE MINES LAND RECLAMATION SITE
(Based on Mass-Balance Calculations)

	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn	TKN	Fecal Coliform
Date	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	CFU/g*
January	<PQL	<PQL	13	279	11	<PQL	8.7	10	<PQL	440	19,849	3,412
February	<PQL	<PQL	15	322	13	<PQL	10	11	<PQL	507	22,868	3,931
March	<PQL	<PQL	39	354	40	<PQL	6.1	30	<PQL	919	43,275	8,666
April	<PQL	<PQL	36	405	34	1.5	12	31	<PQL	1,126	51,162	24,982
May	<PQL	<PQL	37	389	38	1.2	8.4	27	<PQL	1,000	42,383	34,586
June	<PQL	<PQL	54	550	51	1.0	14	41	<PQL	1,399	38,356	468,578
July	<PQL	<PQL	40	434	39	1.5	15	27	<PQL	1,181	30,346	5,934
August	<PQL	<PQL	40	474	44	1.5	17	34	<PQL	1,350	44,308	271,500
September	<PQL	<PQL	55	451	42	1.6	15	38	<PQL	1,801	38,222	147,195
October	<PQL	<PQL	41	531	49	1.4	17	31	<PQL	1,360	45,324	1,612,050
November	<PQL	<PQL	37	460	31	1.6	13	26	<PQL	1,161	32,724	187,306
December	<PQL	<PQL	31	476	36	1.4	16	25	<PQL	1,274	35,615	44,220
Average	**<PQL**	**<PQL**	**37**	**427**	**36**	**1.1**	**13**	**28**	**<PQL**	**1,127**	**37,036**	**234,363**
Maximum	**<PQL**	**<PQL**	**55**	**550**	**51**	**1.6**	**17**	**41**	**<PQL**	**1,801**	**51,162**	**1,612,050**
PQL	11	5.0	6.0	5.0	12	0.6	6.0	6.0	12	8.0	11	
EQ/PC Limit[1]	41	39	-	1,500	300	17	-	420	100	2,800	-	-
Ceiling Limit[2]	75	85	-	4,300	840	57	75	420	100	7,500	-	-

PQL = Practical Quantitation Limit

* Geometric mean fecal coliform density

[1] Pollutant Concentration Limits taken from Table 3, Part 503.13

[2] Ceiling Concentration Limits taken from Table 1, Part 503

2015 BIOSOLIDS ANALYSIS RESULTS
JEFFERSON COUNTY LANDFILL NO. 1
(Based on Mass-Balance Calculations)

	As	Cd	Cr	Cu	Pb	Hg	Mo	Ni	Se	Zn	TKN	Fecal Coliform
Date	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**mg/kg**	**CFU/g***
January	<PQL	<PQL	55	511	24	<PQL	<PQL	29	<PQL	2,348	25,366	499
February	<PQL	<PQL	24	1,000	12	<PQL	7.6	12	<PQL	740	46,000	1,800
March	<PQL	<PQL	24	1,000	12	<PQL	7.6	12	<PQL	740	46,000	1,800
April	<PQL	<PQL	28	341	<PQL	0.9	<PQL	15	<PQL	1,026	16,116	1
May	<PQL	<PQL	49	560	27	1.5	6.1	28	<PQL	2,203	24,316	2
June	<PQL	<PQL	36	984	16	1.9	8.6	19	<PQL	1,147	28,790	1
July	<PQL	<PQL	45	498	30	1.8	<PQL	30	<PQL	2,516	22,264	0
August	<PQL	<PQL	57	471	31	1.6	17	45	<PQL	2,191	36,110	1,182
September	<PQL	<PQL	42	477	<PQL	1.4	<PQL	20	<PQL	629	26,750	4
October	<PQL	<PQL	39	727	17	1.2	13	22	<PQL	810	37,645	33
November	<PQL	<PQL	39	870	34	1.8	14	29	13	730	28,000	0
December	<PQL	<PQL	38	797	19	1.2	8.9	17	<PQL	782	36,189	87
Average	<PQL	<PQL	**40**	**686**	**19**	**1.1**	**7.7**	**23**	**<PQL**	**1,322**	**31,129**	**451**
Maximum	<PQL	<PQL	**57**	**1,000**	**34**	**1.9**	**17**	**45**	**13**	**2,516**	**46,000**	**1,800**
PQL	11	5.0	6.0	5.0	12	0.6	6.0	6.0	12	8.0	11	
EQ/PC Limit[1]	41	39	-	1,500	300	17	-	420	100	2,800	-	-
Ceiling Limit[2]	75	85	-	4,300	840	57	75	420	100	7,500	-	-

PQL = Practical Quantitation Limit

* Geometric mean fecal coliform density

[1] Pollutant Concentration Limits taken from Table 3, Part 503.13

[2] Ceiling Concentration Limits taken from Table 1, Part 503

SECTION 5

AGRONOMIC RATE INFORMATION AND CALCULATIONS

AGRONOMIC RATE
BELTONA LAND RECLAMATION SITE

Summary:

The Beltona Land Reclamation Site is a former strip mine site located in northwestern Jefferson County. The Environmental Services Department is assisting the property owner in the reclamation of this site through the land application of biosolids. In the areas that have not received any biosolids applications, no vegetation other than “scrub” vegetation is present and growing. In the areas that have received biosolids applications, Tifton Bermuda grass has been planted for nitrogen uptake.

The local Agricultural Cooperative Extension Service has recommended a fertilizer rate of 100 lb Nitrogen/Ac/year for each hay harvest at the mine reclamation site. Hay is typically harvested 3 – 4 times per year, resulting in a need for approximately 300 – 400 lb Nitrogen per acre each year.

Agronomic Rate Considerations:

1) The Agronomic Calculations presented in this report are based on an extension bulletin worksheet entitled “Calculating Biosolids Application Rates in Agriculture” (1998), developed by Craig Cogger and Dan Sullivan for the Pacific Northwest. This bulletin uses widely accepted procedures for nitrogen budgeting which are applicable across the United States.

2) During analysis, NH4 + -N is often converted to NH3-N and analytical results are then reported as NH3-N. Both forms are plant available and this combined analysis does not diminish the quality of the result.

3) There is no additional nitrogen applied to the reclamation site by Jefferson County (no fertilizer or irrigation water).

   Biosolids from the Valley and Village WWTP’s are applied with a slinger spreader to each plot on an annual basis throughout the winter months (January – March 2015). Village WWTP biosolids are anaerobically digested, mechanically dewatered, and lime stabilized. Valley WWTP biosolids are anaerobically digested and mechanically dewatered.

4) In 2015, biosolids were applied at a rate of **5.3** dry tons/acre.

AGRONOMIC RATE CALCULATIONS – BELTONA LAND RECLAMATION SITE

FORMULA:

Plant Available Nitrogen (PAN) = Available Organic Nitrogen + Inorganic Nitrogen
= [(Organic Nitrogen)(Organic Mineralization Rate)] + [(NH_4)(%NH_4 Retained) + Nitrate]

GIVEN:

- During analysis, NH_4^+ -N is converted to NH_3-N and analytical results are then reported as NH_3-N. This combined analysis does not diminish the quality of the result.

- The TKN, NH3 and NO3 results are averages of data available during 2015.

  TKN(avg) = 47,472 mg/Kg x 0.002 (converts mg/Kg to lb/dry ton) = 94.9 lb/dt
  NH_3(avg) = 2,950 mg/Kg x 0.002 = 5.9 lb/dt
  NO_3(avg) = 729 mg/Kg x 0.002 = 1.5 lb/dt

  Organic Nitrogen = TKN - NH_3 - NO_3 = 94.9 – 5.9 – 1.5 = 87.5 lb N/dry ton

- Calculations for the Beltona site are performed considering both anaerobically digested/ dewatered, and anaerobically digested/dewatered/lime stabilized biosolids.

NITROGEN CREDITS FOR PREVIOUS BIOSOLIDS APPLICATIONS:

- Biosolids that were applied from 2011 through 2014 had an average Organic Nitrogen content of 38,375 mg/kg. These biosolids were applied at an average rate of 12.6 dry tons per acre. Using Table 1 of the Worksheet:

  Nitrogen Credit for 38,375 mg/kg:
  = 9.9 lb PAN per dry ton (years 2-5) x 12.6 dry tons per acre
  = 125 lb PAN per acre Nitrogen credit

- Tifton Bermuda nitrogen requirements = 300 lb N/Ac/Yr (based on three cuttings of hay in 2015 and the Agricultural Cooperative Extension Service recommendation of 100 lb N/Ac needed for each cutting). With a Nitrogen Credit of 125 lb/acre, approximately 175 lb N/Ac/year is needed from the current applications of biosolids.

AGRONOMIC RATE CALCULATIONS – BELTONA LAND RECLAMATION SITE

CALCULATIONS:

Anaerobically Digested, Dewatered, Lime Stabilized, Not Incorporated

TKN(avg) = 47,472 mg/Kg x 0.002 (converts mg/Kg to lb/dry ton) = 94.9 lb/dt
NH_3(avg) = 2,950 mg/Kg x 0.002 = 5.9 lb/dt
NO_3(avg) = 729 mg/Kg x 0.002 = 1.5 lb/dt

Organic Nitrogen = TKN - NH_3 - NO_3 = 94.9 – 5.9 – 1.5 = 87.5 lb N/dry ton

Organic Nitrogen:
Mineralization Rate (Worksheet, Table 3): Anaerobic Digestion, Dewatered = 20% – 40%

Percent of Organic N available in the first year = 30% (average)

Total Organic Nitrogen available in the first year = 87.5 x 30% = 26.3 lb/dry ton

Ammonium Nitrogen:
% NH_4 Retained (Worksheet, Table 2): Incorporated (0-2 Days), Dewatered = 60%,
Incorporated (0-2 Days), Alkaline Stabilized = 10%
Percent of Ammonia retained after application = 53% (weighted average)

Ammonium Nitrogen retained after application = 5.9 lb/dry ton x 53% = 3.1 lb /dry ton

Estimated Plant Available Nitrogen (PAN):
PAN = Available Organic Nitrogen + Inorganic Nitrogen = 26.3 + 3.1 + 1.5 = 30.9 lb N/dt

Agronomic Rate:
175 lb N/Ac/year ÷ 30.9 lb N/dry ton **=** 5.7 dry tons/Acre/year

Biosolids were applied at the Beltona site throughout 2015 at a rate of 5.3 dry tons per acre. As can be seen from the above calculations, and as required by the 40 CFR Part 503 regulations, the anaerobically digested biosolids are being applied at a rate equal to or less than the agronomic rate for the crops grown.

AGRONOMIC RATE
FLAT TOP/BESSIE MINES LAND RECLAMATION SITE

Summary:
The Flat Top/Bessie Mines Land Reclamation Site is also a former strip mine site located in northwestern Jefferson County. The Environmental Services Department is assisting the property owner in the reclamation of this site through the land application of biosolids. At this site, there is currently marginal soil mass present for growing vegetation, and biosolids are being applied to build adequate soil mass. The County intends to contract with a qualified agronomist or soil scientist to evaluate the site and develop a nutrient management plan with site specific agronomic application rates.

Agronomic Rate Considerations:

1) There is no additional nitrogen applied to the reclamation site by Jefferson County (no fertilizer or irrigation water) and there is very little plant available nitrogen currently present at the site.

2) Approximately 79% of the land applied biosolids were anaerobically digested, followed by either mechanical dewatering or drying beds. The remaining biosolids were aerobically digested, followed by either mechanical dewatering or drying beds. Calculations were performed considering the three biosolids treatment and dewatering scenarios.

3) Approximately half of the anaerobically digested biosolids are lime stabilized.

4) Biosolids from all plants are incorporated into the soil within six (6) hours of application.

5) In 2015, biosolids were applied on a year-round basis at a rate of **30.7** dry tons/acre.

AGRONOMIC RATE CALCULATIONS – FLAT TOP/BESSIE MINES LAND RECLAMATION SITE

FORMULA:

Plant Available Nitrogen (PAN) = Available Organic Nitrogen + Inorganic Nitrogen
= [(Organic Nitrogen)(Organic Mineralization Rate)] + [(NH_4)(%NH_4 Retained) + Nitrate]

GIVEN:

- During analysis, NH_4^+ -N is converted to NH_3-N and analytical results are then reported as NH_3-N. This combined analysis does not diminish the quality of the result.

- The TKN, NH_3 and NO_3 results are averages of data available during 2015. All results are reported on a dry-weight basis.

  TKN(avg) = 37,036 mg/Kg x 0.002 (converts mg/Kg to lb/dry ton) = 74.1 lb/dt
  NH_3(avg) = 2,950 mg/Kg x 0.002 = 5.9 lb/dt
  NO_3(avg) = 729 mg/Kg x 0.002 = 1.5 lb/dt

  Organic Nitrogen = TKN - NH_3 - NO_3 = 74.1 – 5.9 – 1.5 = 66.7 lb N/dry ton

- Being a reclamation site, biosolids are applied at a sufficient rate to build soil mass.

- When soil mass becomes adequate to sustain crop growth, Tifton Bermuda and Rye grass will be planted for nitrogen uptake.

- Calculations will be performed considering three biosolids scenarios: (1) anaerobically digested, dewatered, and lime stabilized, (2) anaerobically or aerobically digested and mechanically dewatered and (3) anaerobically or aerobically digested, mechanically dewatered or drying beds, and incorporated into the soil within six hours of application.

AGRONOMIC RATE CALCULATIONS –
FLAT TOP/BESSIE MINES LAND RECLAMATION SITE

CALCULATIONS:

TKN(avg) = 37,036 mg/Kg x 0.002 (converts mg/Kg to lb/dry ton) = 74.1 lb/dt
NH_3(avg) = 2,950 mg/Kg x 0.002 = 5.9 lb/dt
NO_3(avg) = 729 mg/Kg x 0.002 = 1.5 lb/dt

Organic Nitrogen = TKN - NH_3 - NO_3 = 74.1 – 5.9 – 1.5 = 66.7 lb N/dry ton

Organic Nitrogen:
Mineralization Rate (Worksheet, Table 3): Anaerobic Digestion, Dewatered = 20%-40%
Aerobic Digestion = 30% – 45% Drying
Beds = 15%-30%

Percent of Organic N available in the first year = 30% (weighted average)

Total Organic Nitrogen available in the first year = 66.7 x 30% = 20.0 lb/dry ton

Ammonium Nitrogen:
% NH_4 Retained (Worksheet, Table 2): Incorporated (0-2 Days), Dewatered = 60%, Incorporated
(0-2 Days), Drying Bed = 100%
Incorporated (0-2 Days), Alkaline Stabilized = 10%

Percent of Ammonia retained after application = 43% (weighted average)

Ammonium Nitrogen retained after application = 5.9 lb/dry ton x 43% = 2.5 lb /dry ton

Estimated Plant Available Nitrogen (PAN):
PAN = Available Organic Nitrogen + Inorganic Nitrogen = 20.0 + 2.5 + 1.5 = 24.0 lb N/dt

Application Rate:
7,406 dry tons/year ÷ 241 acres **= 30.7 dry tons/Acre/year**

With 24.0 lb N/dt of plant available nitrogen in the biosolids and an application rate of 30.7 dt/Ac/year, approximately 740 lb N/Ac was applied at this reclamation site in 2015. At a typical site, approximately 200 lb N/Ac/year is needed for adequate crop growth; however, Flat Top is a reclamation site and up to five times the agronomic rate (i.e. 1,000 lb N/Ac) is allowed to be applied at such a site to assist in establishing a soil base. Therefore, the biosolids are being applied to the Flat Top Reclamation Site at a rate less than the maximum allowed when reclaiming these highly disturbed soils.

JEFFERSON COUNTY LANDFILL NO. 1 – SOIL AMENDMENT

Summary:
The Jefferson County Landfill No. 1, more commonly known as the Mt. Olive Landfill, is a municipal solid waste (MSW) landfill located in northern Jefferson County. Although owned by the Jefferson County Commission, the site, operations and management of the landfill is leased to Santek Environmental of Alabama, LLC.

Landfill operators typically excavate the existing soils in an area being prepped for the construction of a new disposal cell and use this soil as the cover material on a cell that is being closed. Native grass seed is then planted to assist in erosion reduction. Because this excavated material contains very little to no organic material, landfill operators often have a difficult time supporting vegetative growth. This is true of the Jefferson County Landfill No. 1 as the excavated soils consist of mostly clayey soils with very little to no organic content.

In early 2014, Santek approached Jefferson County with a proposal to use some of the county's biosolids as a soil amendment for their cover material. The biosolids would be incorporated into the cover material to provide the necessary organic material to sustain the required vegetative growth. Santek sent a request to ADEM in April 2014 to allow the use of drying bed biosolids as a soil amendment to expedite the grassing of their landfill slopes. ADEM approved the requested use in May 2014 as long as the following requirements were met:

1. The application rate of the drying bed biosolids placed on the slope shall not exceed the allowable rates developed by the Alabama Department of Agriculture and Industries for agricultural use;

2. The use of the drying bed biosolids as a fertilizer must be in compliance with ADEM's Water Division;

3. The drying bed biosolids must be placed and used within the lined landfill area as outlined in Santek's request.

APPENDIX A

AGRONOMIC RATE SUPPORTING DOCUMENTATION

ALABAMA COOPERATIVE
Extension
SYSTEM

Your Experts for Life

Jefferson County Extension Office
2121 Building, Suite 1700
2121 8th Avenue North
Birmingham, AL 35203-2387
Telephone: (205) 325-5342
FAX: (205) 325-5690

November 19, 2003

Mr. David Denard
A-300 Courthouse Annex
716 Richard Arrington Jr. Blvd.
Birmingham, Al 35203

David:

Enclosed is a fact sheet that we based our 6001b/N/ACRE recommendation related to the county's hay production/Bio-solid project.

The reasoning behind the high rate of nitrogen is to maximize forage tonnage which in turn will increase sludge uptake and breakdown.

The yearly fertilization schedule is based on six cuttings using 100lb/N/ac/cutting. The extra cuttings comes from over seeding the Bermudagrass with ryegrass in the fall. The ryegrass can be cut twice, while Bermudagrass is normally cut four times each year.

If you have questions or comments related to this schedule, feel free to give me a call.

Sincerely,

David Hubbard
County Extension Agent

DH/fb

PNW0511e

Worksheet for Calculating Biosolids Application Rates in Agriculture

Overview

This bulletin will walk you through the calculations that yield the biosolids agronomic rate. This rate is based on biosolids quality (determined by analytical results), site and crop nitrogen (N) requirements, and regulatory limits for trace element application. In almost all cases, nitrogen controls the biosolids application rate. Calculating the agronomic rate allows managers to match the plant-available N supplied by biosolids with crop N needs.

The calculations consist of 6 steps:

1. Collect information on the site and crop, including crop N requirement.
2. Estimate the plant-available N needed from the biosolids application.
3. Collect biosolids nutrient data.
4. Estimate plant-available N per dry ton of biosolids.
5. Calculate the agronomic biosolids application rate on a dry ton basis.
6. Convert the application rate to an "as is" basis.

To learn more about the use and management of biosolids as a fertilizer, refer to publication PNW0508, "Fertilizing with Biosolids," which is the companion to this bulletin.

Worksheet

Step 1. Collect Site Information.

Soil and crop information:

Line No.		Your Information	Example
1.1	Soil series and texture (NRCS soil survey)		Puyallup sandy loam
1.2	Yield goal (grower, agronomist) (units/acre*)		5 tons/acre/yr
1.3	Crop rotation (grower; e.g., wheat/fallow/wheat)		perennial grass
1.4	Plant-available N needed to produce yield goal (fertilizer guide; agronomist) (lb N/acre/yr)		200

Plant-available N provided by other sources:

Line No.		Your Calculation	Example	Units
	Pre-application testing			
1.5	Nitrate-N applied in irrigation water		10	lb N/acre
1.6	Preplant nitrate-N in root zone (east of Cascades)**		—	lb N/acre
	Adjustments to typical soil N mineralization			
1.7	Plowdown of cover or green manure crop**		—	lb N/acre
1.8	Previous biosolids applications (Table 1, page 8)		30	lb N/acre
1.9	Previous manure applications		—	lb N/acre
	Grower information			
1.10	N applied at seeding (starter fertilizer)		—	lb N/acre

1.11	Total plant-available N from other sources (sum of lines 1.5 through 1.10)		40	lb N/acre

*Yield goals may be expressed as a weight (tons, lb, etc.) or as a volume (bushels).
**Do not list here if these N sources were accounted for in the nitrogen fertilizer recommendation from a university fertilizer guide.

Step 2. Estimate the Amount of Plant-Available N Needed from Biosolids.

Line No.		Your Calculation	Example	Units
2.1	Plant-available N needed to produce yield goal (from line 1.4)		200	lb N/acre
2.2	Plant-available N from other sources (from line 1.11)		40	lb N/acre
2.3	Amount of plant-available N needed from biosolids (line 2.1–line 2.2)		160	lb N/acre

Step 3. Collect Biosolids Data.

Application Information:

Line No.		Your Information	Example
3.1	Moisture content of biosolids (liquid or solid; see Table 3, pg. 11)		liquid
3.2	Biosolids processing method (see Table 3, pg. 11)		anaerobic
3.3	Method of application (surface or injected)		surface
3.4	Number of days to incorporation of biosolids		no incorporation
3.5	Expected application season		Mar. - Sept.

Laboratory Biosolids Analysis (dry weight basis):

If your biosolids analysis is on an "as is" or wet weight basis, you will need to divide your analysis by the percent solids (line 3.10) and multiply the result by 100 to convert to a dry weight basis.

Line No.		Your Calculation	Example	Units
3.6	Total Kjeldahl N (TKN)*		50,000	mg/kg
3.7	Ammonium N*		10,000	mg/kg
3.8	Nitrate N *,**		not analyzed	mg/kg
3.9	Organic N*,*** (line 3.6 - line 3.7)		40,000	mg/kg
3.10	Total solids		2.5	percent

*If your analysis is in percent, multiply by 10,000 to convert to mg/kg.
**Nitrate-N analysis required for composted or aerobically-digested biosolids, but not for anaerobically-digested biosolids. ***Organic N = total Kjeldahl N - ammonium N.

Step 4. Estimate Plant-Available N Per Dry Ton of Biosolids.

Convert biosolids N analysis to lb per dry ton:

Line No.		Your Calculation	Example	Units
4.1	Total Kjeldahl N (TKN)*		100	lb N/dry ton
4.2	Ammonium N*		20	lb N/dry ton
4.3	Nitrate N*		not analyzed	lb N/dry ton
4.4	Organic N (line 4.1 - line 4.2)		80	lb N/dry ton

*Multiply mg/kg (from lines 3.6 through 3.9) x 0.002. If your analyses are expressed in percent, multiply by 20 instead of 0.002.

Estimate Inorganic N Retained:

4.5	Percent of ammonium-N retained after application (Table 2, pg. 10)		55	percent
4.6	Ammonium-N retained after application (line 4.2 x line 4.5/100)		11	lb N/dry ton
4.7	Calculate biosolids inorganic N retained (line 4.3 + line 4.6)		11	lb N/dry ton

Estimate Organic N Mineralized:

4.8	Percent of organic N that is plant-available in Year 1 (Table 3, pg. 11)		35	percent
4.9	First year plant-available organic N (line 4.4 x line 4.8/100)		28	lb N/dry ton

Plant-available N:

4.10	Estimated plant-available N. Add available inorganic N and available organic N (line 4.7 + line 4.9)		39	lb N/dry ton

Step 5. Calculate the Agronomic Biosolids Application Rate.

Line No.		Your Calculation	Example	Units
5.1	Amount of plant-available N needed from biosolids (from line 2.3)		160	lb N/acre
5.2	Estimated plant-available N in biosolids (from line 4.10)		39	lb N/dry ton
5.3	Agronomic biosolids application rate (line 5.1/line 5.2)		4.1	dry ton/acre

Step 6. Convert to "As Is" Biosolids Basis.

Desired Units		Your Calculation	Example
Gallons per acre =	(line 5.3/line 3.10) x 24,000		39,400
Acre-inches per acre =	(line 5.3/line 3.10) x 0.88		1.44
Wet tons per acre =	(line 5.3/line 3.10) x 100		164

How to Use the Worksheet

Step 1. Collect Site Information.

Soil Series and Surface Soil Texture (Line 1.1)

Find the location on the county NRCS soil survey. Record the series name and surface texture of the predominant soil.

Crop Yield Goal (Line 1.2)

Field records are the best source for crop yield estimates. You can find proven yields for most grain farms from the local Farm Service Agency office. For most other cropping systems, grower records are the only source available. Be sure to note whether the yield records are on an "as is" or dry matter basis. Where field records are not available, you can make first-year estimates for a project using NRCS soil surveys, county production averages, or other local data sources.

A site used repeatedly for biosolids application should have yield data collected each year. Use this accumulated data for determining crop nitrogen requirement. If crop yield data is not kept, you may need to conduct additional monitoring (e.g., post-harvest soil nitrate testing) to be sure biosolids are applied at an agronomic rate.

Yield data is typically not available for grazed pastures because grazing animals consume the crop in the field. In these cases omit the yield goal, and go directly to Line 1.4. Estimate plant nitrogen needs from the appropriate pasture fertilizer guide, based on the level of pasture management.

Crop Rotation (Line 1.3)

Consult with the grower and discuss possible crop rotations. Rotations that include root crops or other crops with long post-application waiting periods are not suitable for Class B biosolids applications.

Plant-Available N Needed to Produce Yield Goal (Line 1.4)

You can estimate plant-available N needs by referring to university fertilizer guides or consulting a qualified agronomist.

<u>**University Fertilizer Guides**</u>

Land grant universities (for example, Washington State University, Oregon State University, and the University of Idaho) publish fertilizer guides that estimate plant-available N needs. Use the fertilizer guide most appropriate for the site and crop. For major crops, guides may cover irrigated or rainfed (dryland) cropping and different geographic areas. Don't use guides produced for irrigated sites when evaluating dryland sites. When appropriate guides do not exist, consult the local Extension or Natural Resources Conservation Service office, or a qualified agronomist for assistance.

Nitrogen fertilizer application rates listed in the fertilizer or nutrient management guides are based on field trials under the specified climate and cultural conditions. Growth trial results are averaged over a variety of soil types and years. Note that guide recommendations are not the same as crop uptake. This is because the guides account for N available from mineralization of soil organic matter and the efficiency of N removal by the crop.

The N rate recommended in fertilizer or nutrient management guides assumes average yields, good management practices, and removal of N from the field through crop harvest or grazing. In terms of satisfying crop N needs, plant-available N from biosolids application is considered equal to fertilizer N.

Agronomist Calculations

Because of the general nature of university fertilizer and nutrient management guides, it may be worthwhile to have a qualified agronomist calculate how much plant-available N is needed for a specific field. Always use the same method to calculate the N requirements. You will need to document your reasons for using agronomist calculations instead of the university guide.

Plant-available N provided by other sources (Lines 1.5-1.11)

To make sure there isn't too much nitrogen applied to a crop, you must determine how much nitrogen comes from sources other than biosolids and soil organic matter. These sources of N are grouped into three categories in the worksheet:

- Plant-available N estimated by pre-application testing
- Adjustments to typical soil organic N mineralization (usually obtained from an agronomist)
- Information supplied by the grower

N estimated by pre-application testing (Lines 1.5-1.6)

Irrigation Water

Since the amount of nitrate-N in irrigation water varies, it should be determined by water testing. Irrigation water containing 5 mg nitrate-N per liter will contribute 1.1 pounds of nitrogen per acre inch applied; irrigation water containing 10 mg nitrate-N per liter will contribute 2.3 pounds of N per acre inch.

Preplant Nitrate-N in the Root Zone (east of Cascades)

You can estimate the preplant nitrate-N in the root zone by testing the soil in early spring. Sample in one-foot increments to a depth of at least two feet. University of Idaho Extension Bulletin EXT 704, "Soil Sampling," is a good reference for soil sampling procedures.

Some fertilizer guides use preplant soil nitrate-N when calculating N fertilizer application rates. If you use these guides, don't count soil test nitrate-N in our worksheet—it has already been accounted for in the recommended fertilizer N rate prescribed in the guide.

In dryland cropping systems, soil testing below three feet is used to assess long term N management. Accumulation of nitrate below 3 feet indicates that past N applications were not efficiently utilized by the crop. However, soil nitrate-N below 3 feet is typically not included as a credit when making a N fertilizer recommendation.

Adjustments to typical soil N mineralization (Lines 1.7-1.9)

Nitrogen mineralization is the release of nitrogen from organic forms to plant-available inorganic forms (ammonium and nitrate). Soil organic matter supplies plant-available N through mineralization, but this is accounted for in the fertilizer guides. Sites with a history of cover crops, biosolids applications, or manure applications supply more plant-available N than do sites without a history of these inputs, and biosolids recommendations must be adjusted based on this additional supply of N.

Plowdown of Cover or Green Manure Crops
Green manures and cover crops are not removed from the field, but are recycled back into the soil by tillage. You can get an estimate of the N contributed from this plowdown by referring to the university fertilizer guides, or by estimating the yield and nitrogen concentration of the cover crop. Recovery of green manure N by the next crop ranges from 10-50% of the total N added to the soil by the cover crop. Estimates of plant-available N contributed by green manure crops should be made by a qualified agronomist.

Previous Biosolids Applications
Previous biosolids applications contribute to plant-available nitrogen in the years after the initial application. In the worksheet, they are considered as "N from other sources." We estimate that 8, 3, 1 and 1 percent of the organic N *originally applied* mineralizes in Years 2, 3, 4 and 5 after application (Table 1). After Year 5, biosolids N is considered part of stable soil organic matter and is not included in calculations.

Table 1. Estimated nitrogen credits for previous biosolids applications at a site.

	Years After Biosolids Application			
	Year 2	Year 3	Year 4 and 5	Cumulative (Years 2, 3, 4 , and 5)
Biosolids Organic N as applied	Percent of Organic N Applied First Year			
	8 3		1	13
mg/kg (dry wt basis)	Plant-available N released, lb N per dry ton			
10000	1.6	0.6	0.2	2.6
20000	3.2	1.2	0.4	5.2
30000	4.8	1.8	0.6	7.8
40000	6.4	2.4	0.8	10.4
50000	8.0	3.0	1.0	13.0
60000	9.6	3.6	1.2	15.6

In using Table 1, consider the following example. Suppose:

- You applied biosolids with an average organic N content of 30,000 mg/kg
- Applications were made the previous 2 years
- The application rate was 4 dry tons per acre

Table 1 gives estimates of nitrogen credits in *terms of the organic N originally applied*. Look up 30,000 mg/kg under Year 2 and Year 3 columns in the table. The table estimates 4.8 lb plant-available N per dry ton for year 2, and 1.8 lb plant-available N for year 3 (two-year credit of 6.6 lb N per dry ton). To calculate the N credit in units of lb/acre, multiply your application rate (4 dry ton/acre) by the N credit per ton (6.6 lb N/dry ton). The N credit is 26.4 lb plant-available N per acre.

Previous Manure Applications
Previous manure applications contribute to plant-available nitrogen in a similar manner to previous biosolids applications. To estimate this contribution, consult an agronomist.

Information supplied by the grower (Line 1.10)

N Applied at Seeding
Some crops need a starter fertilizer (N applied at seeding) for best growth. These fertilizers usually supply N, P and S. Examples are 16-20-0, 10-34-0. Starters are usually applied at rates that supply 10–30 lb N per acre. Enter all N supplied by starter fertilizer on line 1.10 in the worksheet.

Step 2. Estimate Plant-Available N Needed from Biosolids.

Next you will estimate the amount of plant-available N the biosolids must provide. This is the difference between the total plant-available N needed to produce the yield goal and the plant-available N from other sources.

Step. 3. Collect Biosolids Data.

To make the calculation, managers will need the following analyses:

- Total Kjeldahl N (TKN)
- Ammonium-N (NH_4-N)
- Nitrate-N (NO_3-N; composted or aerobically digested biosolids only)
- Percent total solids

If your laboratory results are on an "as is" or wet weight basis, you must convert them to a dry weight basis. To convert from an "as-is" to a dry weight basis, divide your analysis by the percent solids in the biosolids and multiply the result by 100. Total Kjeldahl N includes over 95% of the total N in biosolids. In using the worksheet, we will assume that total Kjeldahl N equals total N.

Ammonium-N usually makes up over 95% of the total NH_{4+} inorganic N in most biosolids. Ammonium-N includes both ammonia (NH_3) and ammonium (NH_4^+). Depending on your laboratory, results for ammonium-N may be expressed as either ammonia-N (NH_3-N) or ammonium-N (NH_4^+-N). Make sure that the laboratory determines ammonium-N on a fresh (not dried) biosolids sample. Ammonia-N is lost when samples are oven-dried.

There may be significant amounts of nitrate in aerobically digested biosolids or in composts. There is little nitrate in anaerobically digested biosolids; therefore nitrate analysis is not needed for these materials.

Determine biosolids organic N by subtracting ammonium-N from total Kjeldahl N (line 3.6 –line 3.7). Percent total solids analyses are used to calculate application rates. Biosolids applications are calculated as the dry weight of solids applied per acre (e.g., dry tons per acre).

Step 4. Estimate Plant-Available N Per Dry Ton of Biosolids.

The estimate of plant-available N per dry ton of biosolids includes:

- Some of the ammonium-N
- All of the nitrate-N
- Some of the organic N

Inorganic N Retained (Lines 4.5-4.7)

Ammonium-N (Lines 4.5-4.6)

Under some conditions, ammonium is readily transformed to ammonia and lost as a gas. This gaseous ammonia loss reduces the amount of plant-available N supplied by biosolids. The following section explains the factors used to estimate ammonia-N retained in plant-available form after application.

Biosolids processing
Some types of biosolids processing cause most of the ammonia-N to be lost as ammonia gas or converted to organic forms before application:

- Drying beds
- Alkaline stabilization at pH 12
- Composting

Application method
Ammonia loss occurs only with surface application. Injecting liquid biosolids eliminates most ammonia loss, since the injected liquid is not exposed to the air. Surface applications of liquid biosolids lose less ammonia than do dewatered biosolids. For liquid biosolids, the ammonia is less concentrated and is held as NH_4^+ on negatively-charged soil surfaces after the liquid contacts the soil.

Ammonia loss is fastest just after application to the field. As ammonia is lost, the remaining biosolids are acidified—that is, each molecule of NH_3 lost generates one molecule of H+ (acidity). Acidification gradually slows ammonia loss. Biosolids that remain on the soil surface will eventually reach a pH near 7, and further ammonia losses will be small. Ammonia loss takes place very rapidly after application, with most of the loss occurring during the first two days after application.

Time to soil incorporation
Tillage to cover biosolids can reduce ammonia loss by adsorption of ammonium-N onto soil particles.

Table 2 estimates the amount of ammonium-N retained after field application. To use this table, you will need information on biosolids stabilization processes, method of application (surface or injected), and the number of days to soil incorporation.

Table 2. Estimates of ammonium-N retained after biosolids application.

	Surface-Applied			Injected
Time to Incorporation by Tillage	Liquid Biosolids	Dewatered Biosolids	Composted, air-dried, or heat-dried biosolids	All biosolids
	Ammonium-N retained percent of applied			
Incorporated immediately	95	95	100	100
After 1 day	70	50	100	100
After 2 days	60	30	100	100
No incorporation	55	20	100	100

Nitrate-N (Line 4.3)

We assume 100% availability of biosolids nitrate-N.

Organic N Mineralized (Lines 4.8-4.9)

Biosolids organic N, which includes proteins, amino acids, and other organic N compounds, is not available to plants at the time of application. Plant-available N is released from organic N through microbial activity in soil. This process is called mineralization. This process is more rapid in soils that are warm and moist, and is slower in soils that are cold or dry. Biosolids organic N mineralization rates in soil also depend on the treatment plant processes that produced the biosolids. Use Table 3 to estimate biosolids mineralization rates based on processing. Use the middle of the range presented, unless you have information specific to the site or biosolids that justify using higher or lower values within the range.

Table 3. First year mineralization estimates for organic N in biosolids.

Processing	First-year organic N mineralization rate
	Percent of organic N
Fresh*	
Anaerobic Digestion, liquid or dewatered	30–40
Aerobic Digestion, liquid or dewatered	30–40
Drying Bed	30–40
Heat-dried	30–40
Lagoon	
< 6 months	30–40
6 months to 2 years	20–25
2 to 10 years	10–20
> 10 years	5–10
Composting	0–10
Blends and soil products	†

*"Fresh" includes all biosolids that have not been stabilized by long-term storage in lagoons or composting.
†Because blends (with woody materials) and soil products that contain biosolids vary widely in composition and age depending on intended use, available N may vary widely among products. For blends, available N can be estimated through laboratory incubation studies.

Step 5. Calculate the Agronomic Biosolids Application Rate.

Perform this calculation using the results of the previous sections, as shown in lines 5.1 through 5.3.

Step 6. Convert Agronomic Biosolids Application Rate to “As Is” Basis.

Use the appropriate conversion factors (given in Table 5) to convert to gallons, acre-inches, or wet tons per acre.

Other Considerations for Calculations

- **Small acreage sites without a reliable yield history.** Some communities apply biosolids to small acreages managed by “hobby farmers.” In many of these cases, there is no reliable yield history for the site, and the goal of management is not to make the highest economic returns. You can be sure of maintaining agronomic use of biosolids nitrogen on these sites by applying at a rate substantially below that estimated for maximum yield.

- **Equipment limitations at low application rates.** At some low-rainfall dryland cropping locations east of the Cascades, the agronomic rate calculated with the worksheet will be lower than can be spread with manure spreaders (usually about 3 dry tons per acre). At these locations, you may be able to apply the dewatered biosolids at the equipment limit, but check with your permitting agency for local requirements.

Cumulative Loading of Trace Elements

Under EPA regulations (40 CFR Part 503.13), managers must maintain records on cumulative loading of trace elements only when bulk biosolids do not meet EPA Exceptional Quality Standards for trace elements (Table 4). Contact your regulatory agency for details on record keeping if your biosolids do not meet the standards in Table 4.

Table 4. Trace elements concentration limits for land application.

		Concentration Limit	
Element	Symbol	Exceptional Quality Standard (EPA Table 3)* mg/kg	Ceiling Limit (EPA Table 1)* mg/kg
Arsenic	As	41	75
Cadmium	Cd	39	85
Copper	Cu	1500	4300
Lead	Pb	300	840
Mercury	Hg	17	57
Molybdenum	Mo	**	75
Nickel	Ni	420	420
Selenium	Se	100	100
Zinc	Zn	2800	7500

Source: EPA 40 CFR Part 503.
*EPA Table 3 and Table 1 refer to tables in EPA biosolids rule (40 CFR Part 503).
**Molybdenum concentration standard level is under review by the EPA.

Table 5. Conversion Factors.

1%	=	10,000 mg/kg or ppm
	=	20 lb/ton
1 mg/kg	=	1 ppm .0001 % .002 lb/ton
1 wet ton	=	1 dry ton / (per cent solids x 0.01)

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PNW0511e

APPENDIX B

VECTOR ATTRACTION REDUCTION STATISTICS

VECTOR ATTRACTION REDUCTION STATISTICS

A summary of the total amount of biosolids land applied from each wastewater treatment plant (WWTP) and the typical vector attraction reduction method used for those biosolids is provided in Tables 1 through 3 below.

Table 1

Flat Top/Bessie Mines Land Reclamation Site
Summary of 2015 Vector Attraction Reduction (VAR) Methods

Jefferson County WWTP	**Amount of Biosolids Land Applied (dry tons)**	Vector Attraction Reduction Method
Cahaba River	649.2	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Five Mile Creek	759.1	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Leeds	60.8	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Trussville	51.0	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Turkey Creek	13.6	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Valley Creek	2,705.5	Option 1: Volatile Solids Reduction by a minimum of 38 percent [503.33(b)(1)] Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Village Creek	3,130.4	Option 6: Addition of Alkaline Material [503.33(b)(6)] Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Prudes Creek	36.4	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Warrior	0.0	Option 10: Incorporation of Biosolids into the Soil [503.33(b)(10)(i)]
Total Amount of Biosolids Applied at Flat Top:	**7,406 dry tons**	

Table 2

Beltona Land Reclamation Site
Summary of 2015 Vector Attraction Reduction (VAR) Methods

Jefferson County WWTP	Amount of Biosolids Land Applied (dry tons)	Vector Attraction Reduction Method
Valley Creek	647.8	Option 1: Volatile Solids Reduction by a minimum of 38 percent [503.33(b)(1)]
Village Creek	112.4	Option 6: Addition of Alkaline Material [503.33(b)(6)]
Total Amount of Biosolids Applied at Beltona:	**760 dry tons**	

APPENDIX C

SITE MAPS

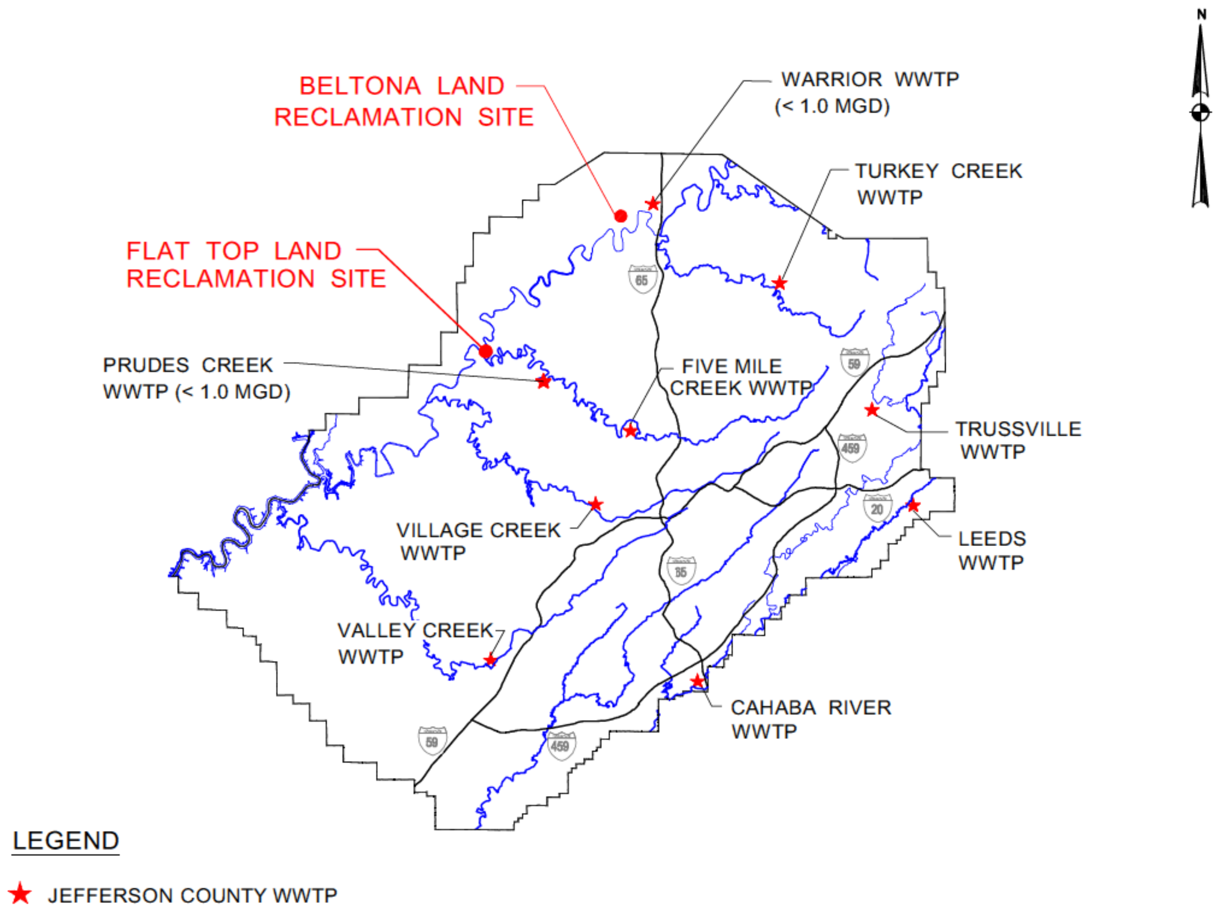

Figure 1: Jefferson County Biosolids Land Application Program

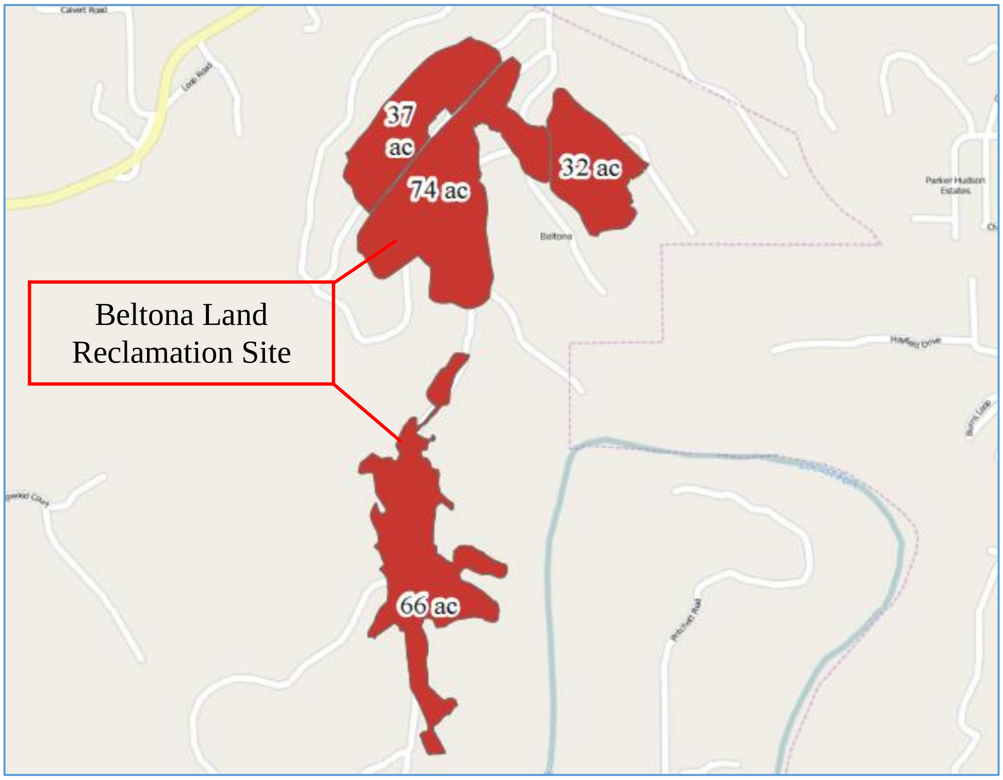

Figure 2: Beltona Land Reclamation Site

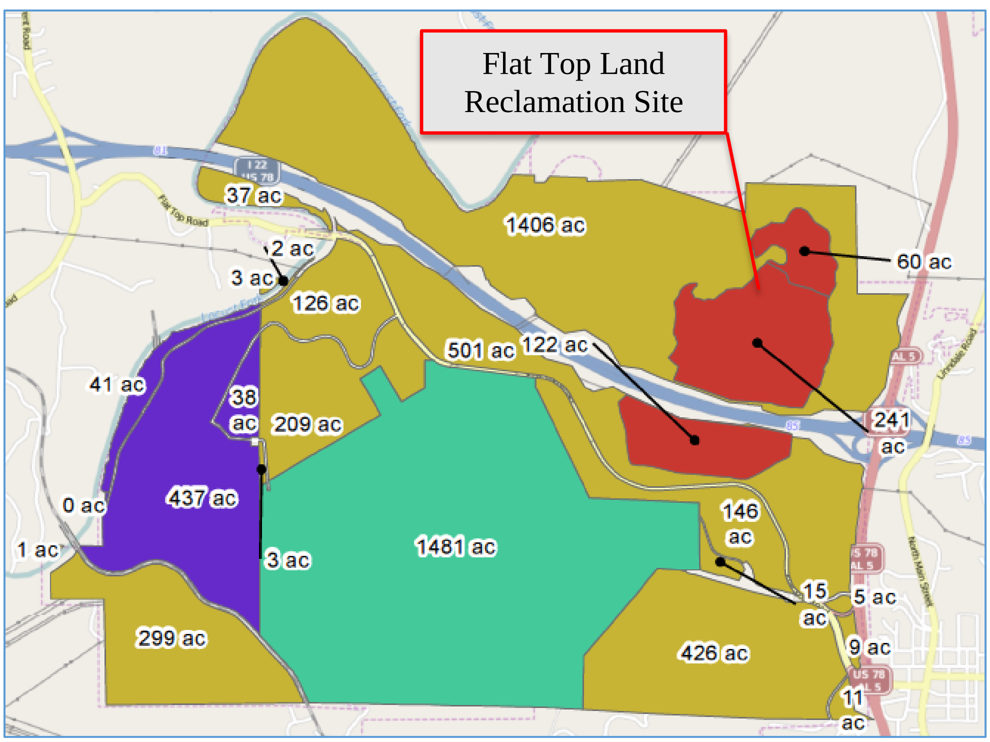

Figure 3: Flat Top Land Reclamation Site